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(71) Applicant *(for all designated States except US)*: ETP TRANSMISSION AB [SE/SE]; P.O. Box 1120, S–581 11 Linköping (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: SAMELIUS, Anders [SE/SE]; ETP Transmission AB, P.O. Box 1120, S–581 11 Linköping (SE).

(74) Agents: HULTMAN, Olle et al.; Axel Ehrners Patentbyrå AB, P.O. Box 10316, S–100 55 Stockholm (SE).

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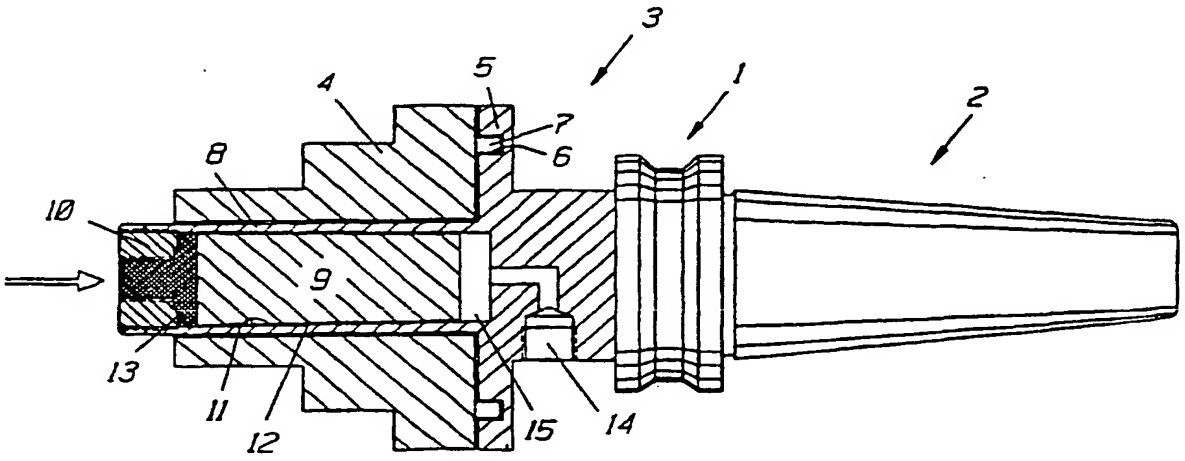
(54) Title: HYDROMECHANICAL MANDREL



(57) Abstract

A hydromechanical mandrel, preferably intended to be mounted, with one end (2) thereof, in a rotary machine tool, and to releasably carry, with the opposite end (3) thereof, one or more tools (4) of the type having an axial central bore, and in which apparatus said opposite end, named the mandrel pin (3), is formed with a smooth outer surface and so that one or more tools (4) can be slided ontosame, and can be secured, on the outer surface of the mandrel, and whereby the mandrel pin (3) is formed as a hydromechanical clamp bushing comprising a sleeve (8) which is formed integral with the mandrel and which has a relatively thin, radially expandable wall and an inner surface (11) which is slightly widened in the direction towards the free end of the sleeve (8), and a piston (9) which is axially displaceable in said sleeve (8) and which has the same conical shape (12) as that of the inner surface (11) of the sleeve (8), and in which the mandrel further comprises means for hydraulic pressurization of a pressure chamber (13) at the outer end of the sleeve (8) thereby forcing the piston (9) inwards in the sleeve (8) by means of a hydraulic pressure medium, and means at the opposite end for pressurization of a release pressure chamber (15) thereby forcing the piston (9) back to its initial position.

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HYDROMECHANICAL MANDREL

The present invention generally relates to a mandrel which is preferably intended to be mounted, with one end thereof, in a rotary machine tool, for instance in a lathe machine, a milling machine, a drilling machine etc., and to releasably carry, with the opposite end thereof, one of more working tools of the type which are formed with an axial central bore, for instance a face cutter, a saw blade, a transition element or a similar means. The mandrel can be used relesably of fixedly mounted in the machine tool. In case the mandrel is of releasable type it is, for instance, mounted by means of a mandrel cone part.

Different types of mandrels of the said type are known in the art. Such known mandrels are generally formed so that the exchangeable tool or tools are fixed in the direction of rotation by mechanical means like keys, splines or similar means, or by means of heat press joints, and in the axial direction by means of nuts or screws. Such mechanical locking means do not provided a prefect precision and they may introduce radial play for the working tool, and it can often be difficult to provide a perfect centring, and this, in turn, can give rise to unsatisfactory balancing and vibrations in the working tool and the machine tool. It may also often be a difficult and time consuming operation to release the joint between the mandrel and the tools, especially in case the tools are mounted by heat press joints.

The present invention is intended to solve the above mentioned problems and disadvantages and to provide a mandrel for use in rotary machine tools, and which is formed, at its free end, so that one or more tools can be slided onto and can be secured without use of keys, splines and other mechanical locking means at the envelope surface of the mandrel, or by means of press joints, and in which there is obtained a perfect centering and balancing of the tool or tools. The mandrel is also intended to provide a very powerful clamp connection.

According to the invention this is provided in that the mandrel pin is formed as a hydromechanical clamp bushing comprising a sleeve which is formed integral with the mandrel and which has a relatively thin wall having an inner surface which tapers slightly towards the free end of the sleeve, and further comprising a piston which is displaceable inside the inner of the sleeve, and which has the same conical shape as that of the sleeve. For providing a displacement of the piston in the sleeve said sleeve is closed at the outer end

thereof by a nipple which makes it possible to introduce a hydraulic pressure medium for forcing the piston towards the inner end of the sleeve, thereby providing a radial expansion of the sleeve and a locking engagement of the tool or tools, and having a central bore, on the outer surface of the sleeve. For making it possible to force the piston back, thereby releasing the tool or tools from the mandrel pin, the sleeve is, at the inner end thereof, connected to means for introducing a hydraulic pressure medium at said end of the sleeve-piston chamber.

The sleeve and the piston are formed with such cone angle as to provide a self locking engagement in any position of the piston in the sleeve. The nipple at the end of the sleeve can be fixedly connected, or it can be formed as an externally threaded nipple which is screw connected to the inner end of the sleeve.

For providing a safe locking engagement, against rotation of the tools on the mandrel, the tool, or the tool which is mounted closest to the mandrel head can be formed with a pair of follower pins adapted to engage corresponding follower bores of the mandrel head.

Now the invention is to be described more closely with reference to the accompanying drawing, in which figure 1 shows a hydromechanical mandrel according to the invention in a partly cut open condition, and combined with a tool having a central bore. Figure 2 correspondingly shows the hydromechanical mandrel with the tool released from the mandrel.

The hydromechanical mandrel shown in the drawings generally comprises a transition part 1, in the drawings shown as a flange having a V-shaped groove, a mandrel cone part 2 for engagement of the mandrel in a corresponding cone cavity of a rotary machine tool, and a mandrel pin 3 for releasable connection one or more tools 4 and for securing same on the mandrel pin 3. The mandrel head 1, the cone part 2 and the mandrel pin 3 are formed as an integral unit.

The mandrel head 1 and the mandrel cone part 2 are of a type known per se and do not need any closer description. The cone part 2 is adapted for being introduced in a corresponding conically formed cavity of a rotary machine tool, for instance in a lathe machine, a milling machine, a drilling machine or a similar machine. It is, of course, also possible to form the mandrel cone part 2 as an integral part of the machine tool, whereby only the mandrel pin 3 provides the inventional part of the claimed apparatus.

For making it possible to clamp connect one or more rotary tools 4 on the mandrel pin 3, said pin is, as shown in the drawings, formed with a smooth cylindrical surface. Said surface can, however, have a polygonal, square, octagonal etc. cross section shape. The surface also can be threaded, serrated etc. The surface also can be formed with several consecutive diameters. The tools can be pushed into butt contact with a projecting flange 5 of the transition part 1. If desired said flange 5 can be formed with a couple of bores 6 in which follower pins 7 of the closest tool part can engage for making the tool follow the rotary movement. Alternatively the tools can be formed with axial bores, through which clamp screws can be introduced and can be thread connected to the bores 6 of the flange 5.

Rather than using bores 6 and pins 7, a torsion stiffness can be obtained by using key and pin joints of priorly known types. If desired, it is also possible to make use of (diameter reduction) sleeves of different types which are introduced between the tool 4 and the sleeve 8.

The mandrel pin 3 is formed as a hydromechanical cone piston bushing, and to that end it is formed with two main parts, namely a sleeve 8 which is fixedly connected to the mandrel and which has such relatively thin outer wall that it is capable of expanding radially outwards when being acted on from inside the sleeve, and a piston 9 which is displaceable inside said sleeve 8. The sleeve 8 is closed at the free end thereof, for instance by a threaded nipple 10. The sleeve has an inner surface 11 which is slightly conically widened in the direction outwards from the transition part 1, and the piston 9 has a correspondingly cone shaped outer surface 12. The cone angle of the sleeve 8 and the piston 9 is such that the piston is self-locking in each individual position in the sleeve. The cone surfaces 11 and 12 of the sleeve and the piston provide a mutual sealing, and the piston has such shape that it is located adjacent the nipple 10 in the unpressurized condition of the mandrel.

For making it possible to force the piston 9 inwards in the sleeve 8 , thereby providing a radial expansion of the sleeve wall, as shown in figure 1, the nipple 10 is formed as a pressurization nipple by means of which a hydraulic pressure medium can be pressed into a pressure chamber 13 which is present between the nipple 10 and the outer end of the piston 9.

Since the piston 9 is self-locking in the sleeve 8 the piston does not automatically return to its initial, unpressurized position, and therefore the

apparatus comprises a second pressurization nipple 14 provided at the inner end of the sleeve 8. Through said second pressurization nipple 14 a hydraulic pressure medium can be introduced in a release pressure chamber 15, so that the piston 9 can be forced back to its original position shown in figure 2 concurrently with evacuation of the pressure medium of the said first pressurization chamber 13, whereby the walls of the sleeve 8 return to their non-expanded original position, and the tool or tools are thereby released from the mandrel pin 3.

It is not necessary that the nipple 14 is located as shown in the drawings, but pressurization means can be arranged at other places, for instance at the transition part 1.

By the described apparatus tools can easily and quickly be exchanged, and the tools get a perfect centering and a perfect balancing on the mandrel pin. It is also possible to let the tools be remained on the mandrel pin after a machining operation has been performed, and, in case of repeated machining with the same tool, save the entire mandrel with the tool mounted thereon and to re-use same in connection to the next machining operation.

The mounting of tools on the mandrel is made in that it is firstly foreseen that the piston 9 is in its retracted, unpressurized position adjacent the end nipple 10; one or more tools 4 are slided onto the mandrel pin 3, and, if actual, with the follower pins 7 introduced in the follower bores 6 of the flange 5 of the mandrel head; pressure medium of a predetermined pressure is introduced in the pressure chamber 13 through the bottom nipple 10, whereby the sleeve 8 expands radially, whereby the tools 4 become centered, balanced and secured on the mandrel pin.

The tools 4 are released in that the pressure chamber 13 is evacuated, and the release pressure chamber 15 is pressurized, whereby the piston 9 is forced bach to its original position, and whereby the sleeve 8 is de-expanded and the tools 4 are released from the mandrel pin 3.

It should be noted that the chambers 13 and 15 need not pressurized during operation since the tool or tools are secured solely by a mechanical joint. The hydraulic pressurization is only used for mounting and dismounting of the tool(s).

REFERENCE NUMERALS

1	transition part
2	mandrel cone part
3	mandrel pin
4	tool
5	flange
6	follower bore (of flange)
7	follower pin
8	sleeve
9	piston
10	pressure nipple
11	cone surface (of sleeve 8)
12	cone surface (of piston 9)
13	pressure chamber
14	pressure medium connection
15	release pressure chamber

CLAIMS

1. Hydromechanical mandrel, preferably intended to be mounted, with one end (2) thereof, in a rotary machine tool, and to carry, with the opposite end (3) thereof one or more tools (4) of the type having an axial central bore, and in which said opposite end is formed as a mandrel pin (3) having an outer envelope surface onto which one or more tools (4) can be slided and can be secured without the use of keys, splines and other types of mechanical locking means provided on the outer surface of the mandrel pin, or by means of press joints, and whereby there is obtained a perfect centering of the tool or tools, **characterized** in that the mandrel pin (3) is formed as a hydromechanical clamp bushing comprising a sleeve (8) having a relatively thin, radially expandable wall and an inner surface (11) which tapers slightly in the radial direction, and a piston (9) which is axially displaceable in said sleeve (8) and which has the same conical shape (12) as that of the inner surface of the sleeve (8), and further comprising means for hydraulic pressurization of a pressure chamber (13) thereby providing a displacement of the piston (9) in the sleeve (8) and thereby a radial expansion of the sleeve (8).

2. Hydromechanical mandrel according to claim 1, **characterized** in that the conicity of the sleeve (8) is such that the diameter of the sleeve increases in the direction towards the outer end thereof.

3. Hydromechanical mandrel according to claim 1 or 2, **characterized** in that the sleeve (8) is closed at the outer end thereof by means of a fixed nipple or a nipple (10) which is threaded into the sleeve end, and through which a hydraulic pressure medium can be introduced in the pressure chamber (13) between the nipple (10) and the adjacent end of the piston (9).

4. Hydromechanical mandrel according to claim 1, 2 or 3, **characterized** in that the inner surface (11) of the sleeve (8) and the outer surface (12) of the piston (9) are widened in the direction outwards from a transition part (1) and the inner end of the mandrel pin (3).

5. Hydromechanical mandrel according to claim 4, **characterized** in that the cone surfaces (11, 12) of the sleeve (8) and the piston (9) are formed with a self locking cone angle.

6. Hydromechanical mandrel according to any of the preceding claims, **characterized** in that the mandrel is formed with a pressure medium connection (14) at the inner end of the mandrel, which pressure medium

connection (14) opens in a release pressure chamber (15) into which a hydraulic pressure medium can be introduced thereby returning the piston (9) to its initial position in which the sleeve (8) is non-expanded.

7. Hydromechanical mandrel according to any of claims 4 - 6, characterized in that the transition part (1) has follower bores (6) in which follower pins (7) of the tool can be introduced.

AMENDED CLAIMS
[received by the International Bureau on 28 May 1998 (28.05.98);
original claims 1-7 replaced by amended claims 1-7 (2 pages)]

1. Hydromechanical mandrel, preferably intended to be mounted, with one end (2) thereof, in a rotary machine tool (cone part 2), and to carry, with the opposite end (3) thereof, one or more tools (4) of the type having an axial central bore (bore type tool), and in which said opposite end is formed as a mandrel pin (3) having an outer envelope surface onto which one or more tools (4) can be slided and can be secured without the use of keys, splines and other types of mechanical locking means provided on the outer surface of the mandrel pin, or by means of press joints, and whereby there is obtained a perfect centering of the tool or tools, **characterized** in that the mandrel pin (3) is formed as a hydromechanical clamp bushing comprising a sleeve (8) having a relatively thin, radially expandable wall and an inner surface (11) which tapers slightly in the radial direction, and a piston (9) which is axially displaceable in said sleeve (8) and which has the same conical shape (12) as that of the inner surface of the sleeve (8), and in that there is a pressure chamber (13, 15) at each end of the piston (9) for hydraulic pressurization of a pressure chamber (13) thereby providing a displacement of the piston (9) in the sleeve (8) and thereby a radial expansion of the sleeve (8), or a pressure release, respectively, providing a radial contraction of the sleeve (8).

2. Hydromechanical mandrel according to claim 1, **characterized** in that the conicity of the sleeve (8) is such that the diameter of the sleeve increases in the direction towards the outer end thereof.

3. Hydromechanical mandrel according to claim 1 or 2, **characterized** in that the sleeve (8) is closed at the outer end thereof by means of a fixed nipple or a nipple (10) which is threaded into the sleeve end, and through which a hydraulic pressure medium can be introduced in the pressure chamber (13) between the nipple (10) and the adjacent end of the piston (9).

4. Hydromechanical mandrel according to claim 1, 2 or 3, **characterized** in that the inner surface (11) of the sleeve (8) and the outer surface (12) of the piston (9) are conically widened in the direction outwards from a transition part (1) at the inner end of the mandrel pin (3).

5. Hydromechanical mandrel according to claim 4, **characterized** in that the cone surfaces (11, 12) of the sleeve (8) and the piston (9) are formed with a self locking cone angle.

6. Hydromechanical mandrel according to any of the preceding claims, **characterized** in that the mandrel is formed with a pressure medium connection (14) at the inner end of the mandrel, which pressure medium connection (14) opens in a return pressure chamber (15) into which a hydraulic pressure medium can be introduced thereby returning the piston (9) to its initial position in which the sleeve (8) is non-expanded.

7. Hydromechanical mandrel according to any of claims 4 - 6, **characterized** in that the transition part (1) has follower bores (6) in which follower pins (7) of the tool can be introduced.

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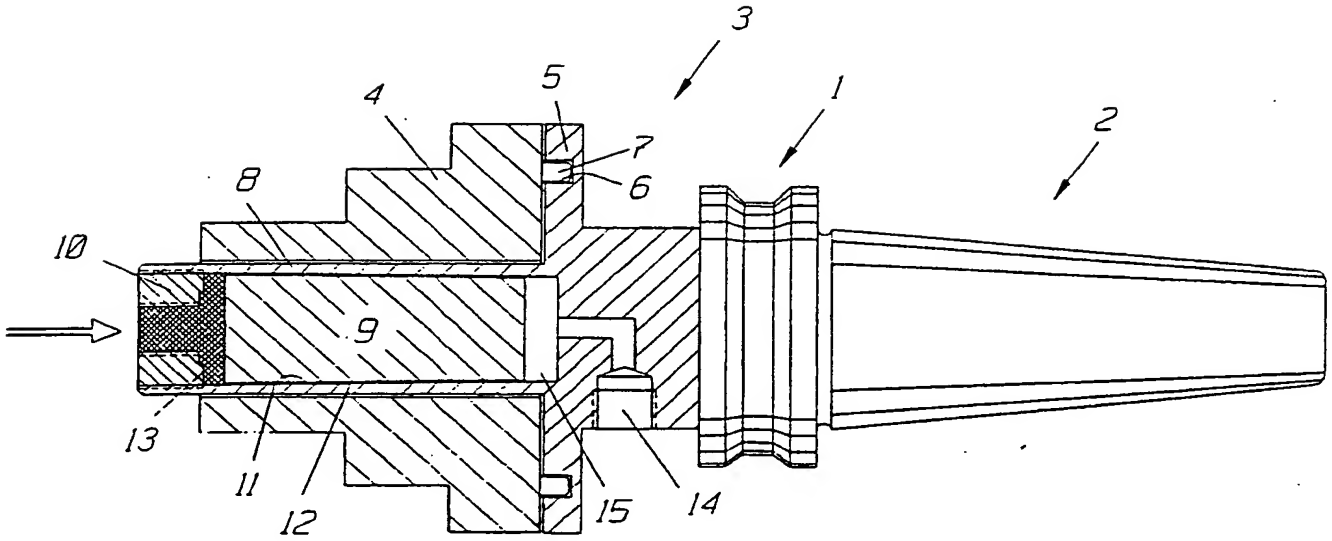

Fig. 1

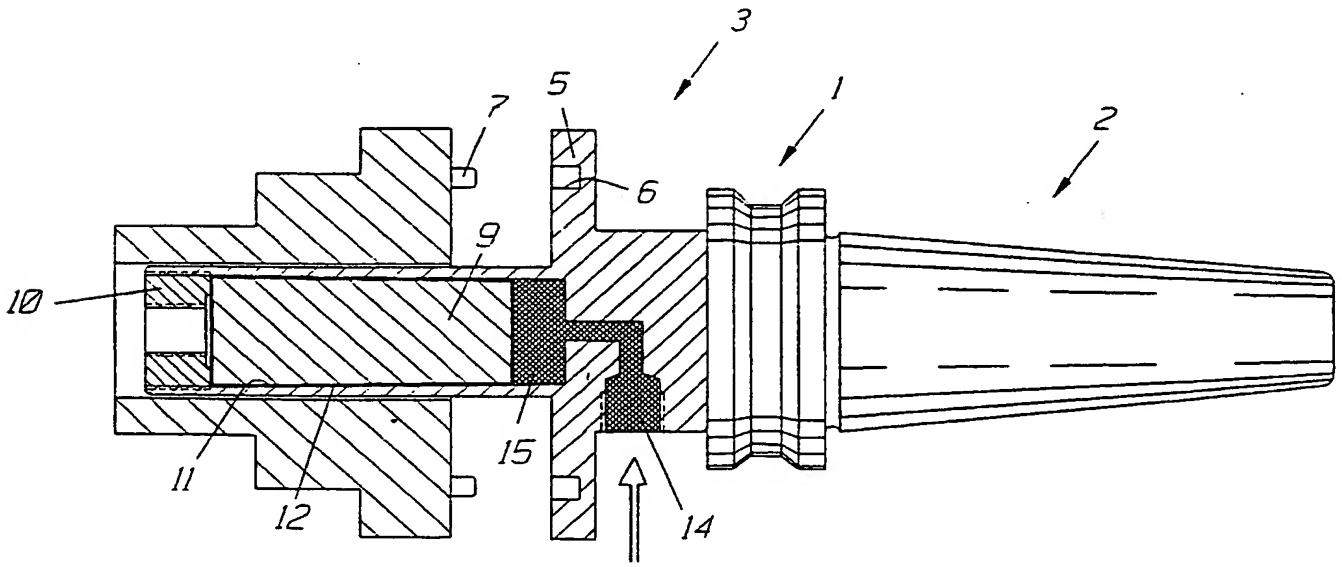

Fig. 2

PATENT COOPERATION TREATY

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Applicant's or agent's file reference P-2405-PC	**REPLY DUE** See paragraph 1 below
International application No. PCT/SE97/02197	International filing date *(day/month/year)* 19-12-1997
Applicant ETP Transmission AB et al	

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Form PCT/ISA/224 (January 1994)

PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P02405-PC	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/SE 97/02197	International filing date *(day/month/year)* 19 December 1997	(Earliest) Priority Date *(day/month/year)* 28 January 1997
Applicant ETP Transmission AB et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] **Certain claims were found unsearchable** (See Box I).

2. [ ] **Unity of invention is lacking** (See Box II).

3. [ ] The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
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   - [ ] furnished by the applicant separately from the international application,
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4. With regard to the title,
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   - [ ] the text has been established by this Authority to read as follows:

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   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is:
   Figure No. 1
   - [X] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

CORRECTED

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/02197

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B23B 31/30
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0574683 A2 (ELSNER, ERNST), 22 December 1993 (22.12.93) --	1-7
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A	WO 9426448 A1 (E T P TRANSMISSION AB), 24 November 1994 (24.11.94) --	1-7

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 1998	28 -08- 1998
Name and mailing address of the ISA: Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer TYCHO BECKMAN Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

27/07/98

International application No.
PCT/SE 97/02197

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